Identification and phenotypic characterisation of quantitative resistance to blackleg in canola

CSIRO AGRICULTURE & FOOD
www.csiro.au

marcroft GRAINS PATHOLOGY

THE UNIVERSITY OF MELBOURNE

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

CSIRO

Luke Barrett

Plant-microbe interactions

Viv Rolland

Imaging

Evans Lagudah

Wendelin Schnippenkoetter

APR genes in cereals

Quantitative resistance (QR)

- Critical for sustainable control of blackleg in Australia

- Difficult to work with
  - multiple minor genes involved
  - strong environmental effects
  - masked by effective major genes
  - limited defined germplasm stocks

- Lack fundamental knowledge on interaction & repeatable screening method
  - Field screening – disease nurseries in multiple locations

Project outcomes

1. Accurate & precise phenotyping method for fine-scale differentiation of QR
    - marker development

2. Higher throughput phenotyping method for screening breeding material

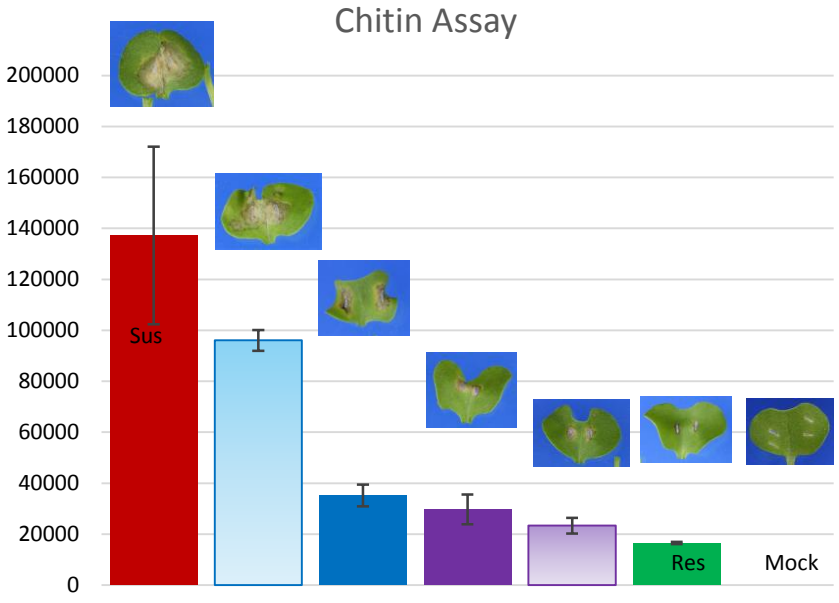
3. Development of genetic stocks in Australian-adapted background

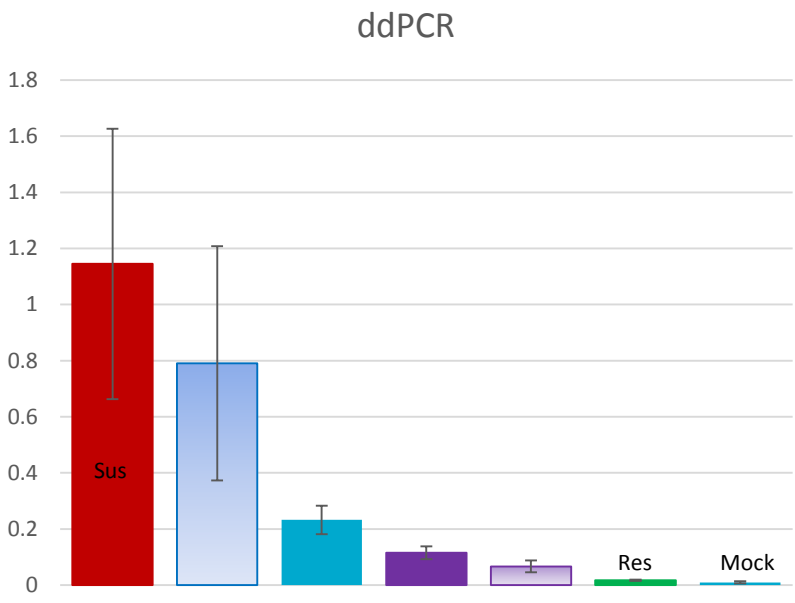
4. Blackleg adaptation to QR

1. Precise phenotyping

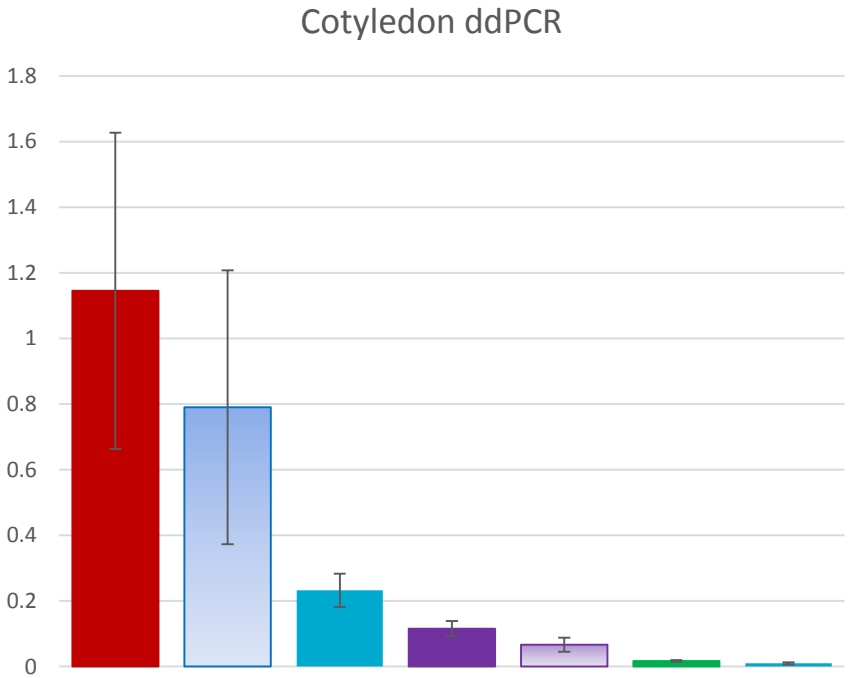
- Unable to bipass major gene resistance
- Controlled environment – repeatable
- Assays
  - qPCR & ddPCR – specific to *L. maculans* & high resolution
  - chitin – not specific to blackleg & lower resolution
- Visualisation of hyphal growth
- Imaging

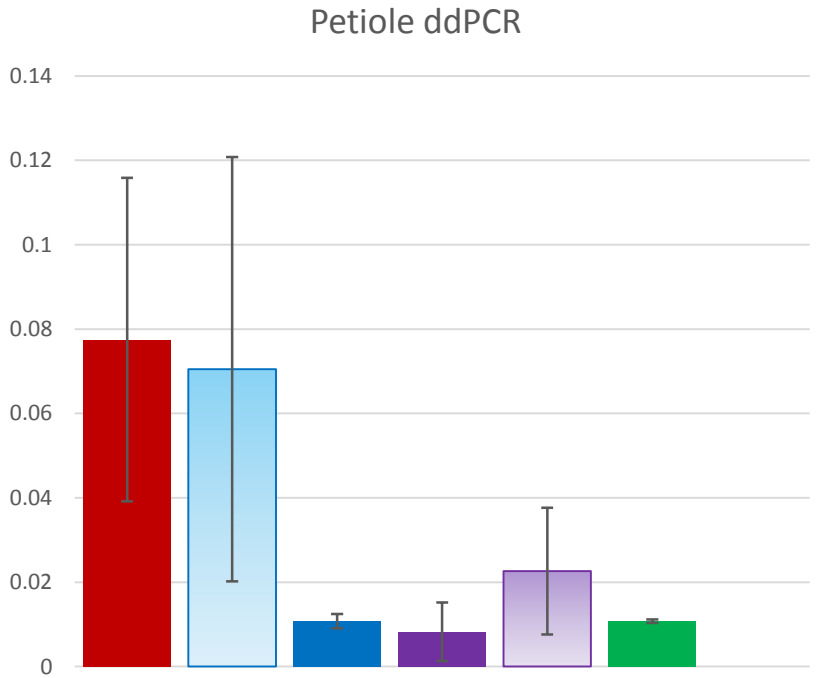
Bioassays detect biomass differences in cotyledons





ddPCR detection in different host tissues





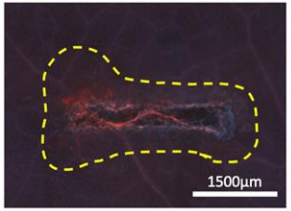
Westar

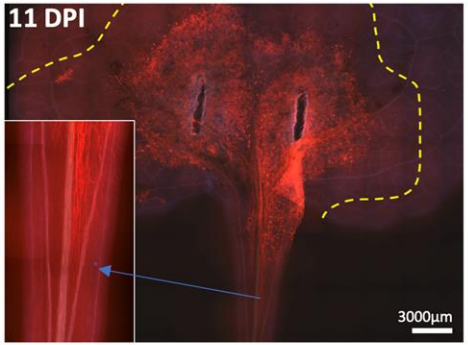
6 DPI

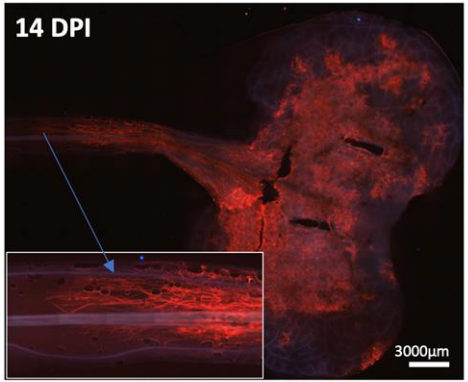
11 DPI

14 DPI

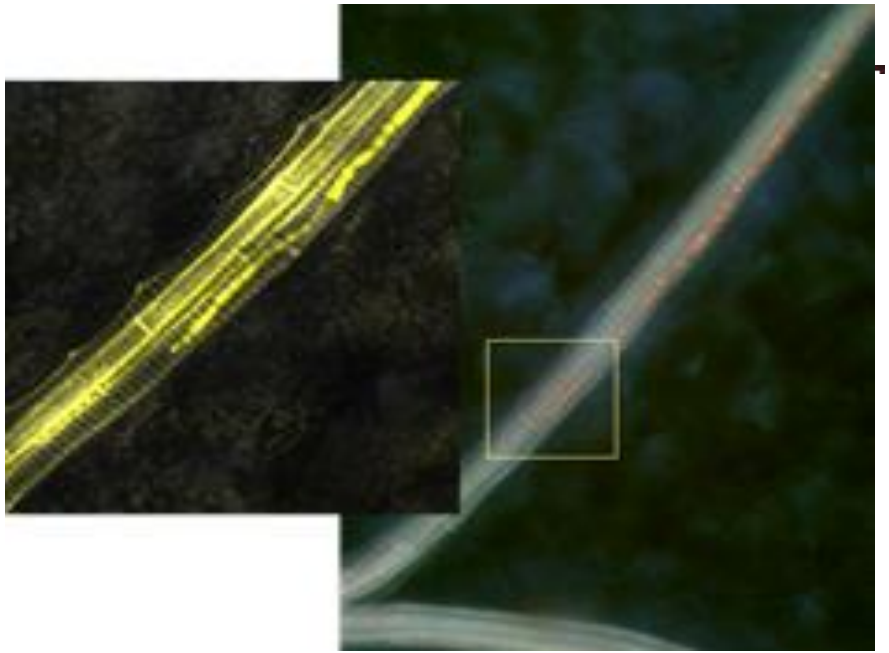
Westar
6 DPI







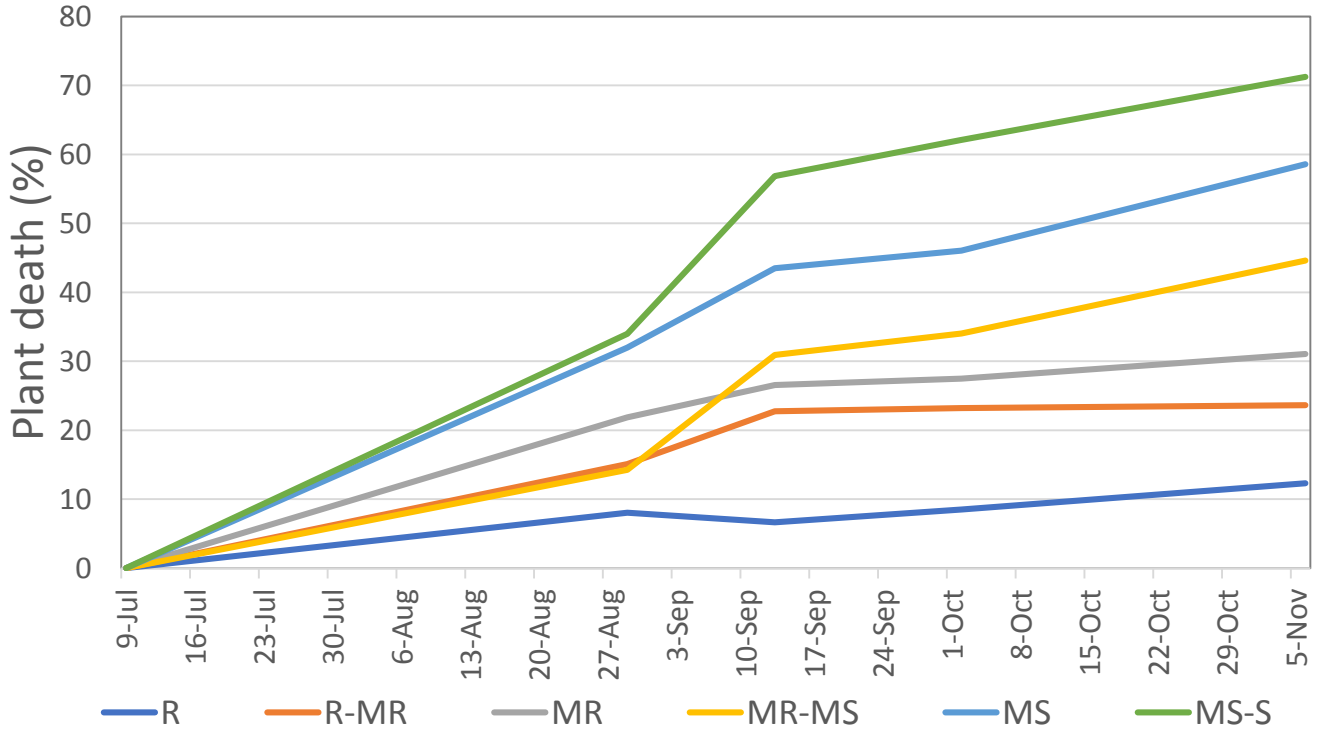
Fluorescence microscopy



A minor setback!

Greg via Riot-act

2. Higher throughput phenotyping



Wangary, SA 2019

3. Genetic stocks – measurable effects of defined single and multiple QTL's

	QR phenotype components
LepQ-A01	?
LepQ-A08	?
LepQ-C06	?
LepQ-A01+ LepQ-A08	?
LepQ-A01+ LepQ-C06	?
LepQ-A08+ LepQ-C06	?
LepQ-A01+ LepQ-A08 + LepQ-C06	?

- *LepQ-A02* **(ex Darmor) to be added**
- **Available stocks in Topas background**
- **Introduce stocks into susceptible derivative devoid of resistance suppressor**

Collaborators- AgCanada

4. Blackleg adaptation to QR

Blackleg rating	**Average CSII**
R	21
R-MR	18
R-MR	33
MR	40
MR-MS	48
MS	62
MS	58
MS-S	76
MS-S	75

Next steps

1. Finescale phenotyping

- tissues/growth stages to differentiate QR response
- improved disease expression
    - inoculum – pycnidiospores vs ascospores
    - environment

2. Higher throughput phenotyping

- repeat measures in disease nurseries
- exploit under controlled conditions

4. Blackleg adaptation to QR

Row Labels	R gene	Blackleg rating	D2	D3	D8	D16	D17	D20	D21	D22	D23	Average
ATR-Bonito	A	MS	50	42	39	79	39	40	74	94	96	62
ATR-Mako	A	MR	16	24	39	63	13	11	62	66	69	40
AV-Sapphire	B	?	43	34	54	55	21	45	93	89	50	54
BASF3000TR	B	MS-S	62	54	65	73	98	43	94	98	100	76
DG408	AC	MS	25	20	64	35	61	50	86	89	91	58
Hyola575	BF	R	3	23	16	29	9	25	19	12	10	16
Hyola580CT	BC	R-MR	33	9	14	21	4	23	41	7	15	18
Pioneer43Y92	B	R-MR	36	9	42	33	29	17	49	43	41	33
PioneerSturt	C	MS-S	49	53	78	91	74	40	95	99	92	75
Stingray	C	MR-MS	44	34	25	71	60	35	44	59	63	48
Tornado	B	?	66	83	88	55	26	58	67	47	91	65

Next steps

3. Genetic stocks

- Bulk & screen Canadian germplasm – single/multiple QTL NIL's
- Darmor-bzh crosses
- Identifying appropriate susceptible background for crossing

4. Blackleg adaptation

- screen progeny from 'vir' x 'avr' crosses